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DEMAND FLUID REGULATOR

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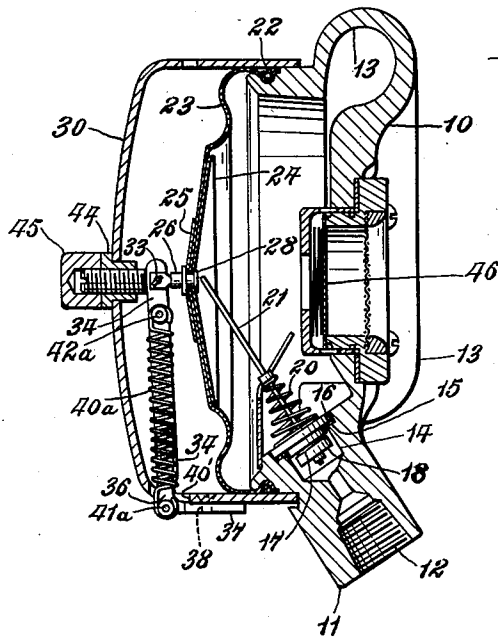


Fig. 1.

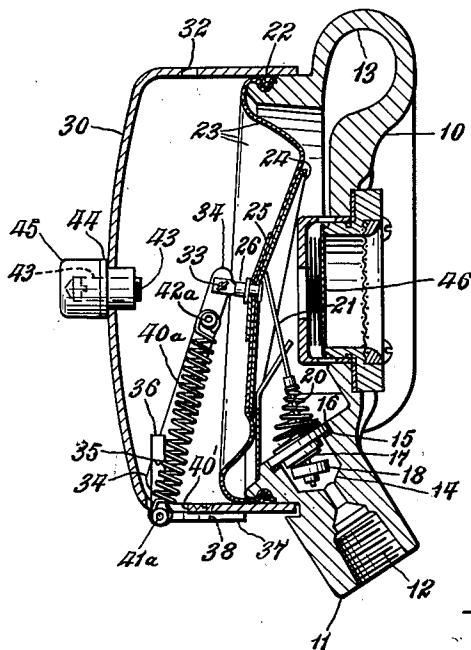
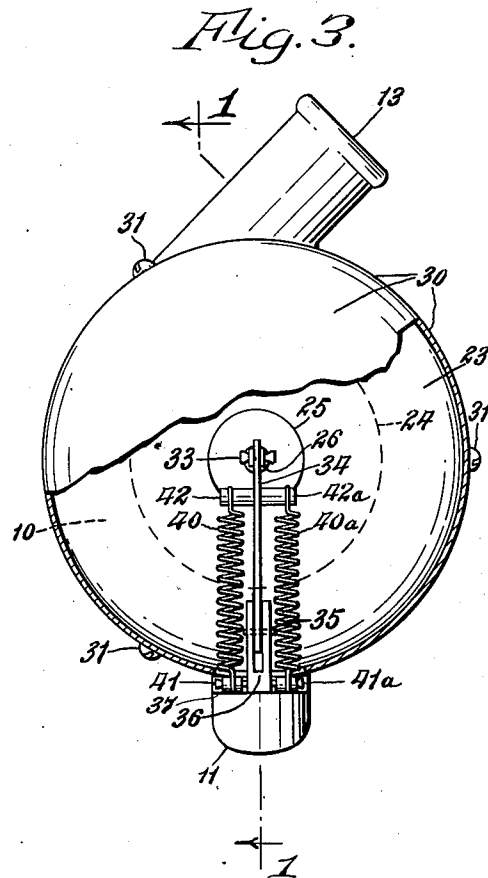


Fig. 2.



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DEMAND FLUID REGULATOR

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This invention relates to a fluid regulator of the demand type, and more particularly to a demand type of oxygen regulator which is supplied by oxygen under substantially constant pressure and acts to regulatedly feed said oxygen to a breathing mask in accordance with the inhalation and exhalation breathing sequences of the person who is wearing the mask. This invention is more specifically intended for use in a hospital where oxygen or air under constant pressure is available, either supplied thru stationary pipes from an oxygen or air compressor, or from a high pressure oxygen or air tank provided with a reduction valve.

This improved regulator is neither an ordinary demand regulator nor is it a positive-pressure, demand regulator. It is a novel combination of both of these main types of regulators. For instance, at the start of the inhalation cycle, the present invention is similar to a conventional demand regulator in that a sub-ambient pressure is required in the mask to initially open the demand valve. However, the present invention is similar to a conventional, positive-pressure, demand regulator, as far as the rest of the inhalation cycle and the initial portion of the exhalation cycle is concerned, inasmuch as the pressure is higher than ambient during these particular portions of the cycle of operation.

The principal object of the present invention is to provide a demand type of fluid regulator which is essentially of the positive-pressure type, and yet is so constructed that, when it is not use, the diaphragm will be completely clear of the demand valve, so that no leakage from the demand valve can occur at this time, as a consequence of the diaphragm "leaning" accidentally against said demand valve. Other collateral objects of the invention and practical solutions thereof are to be found in the following specification and in the appended drawing, wherein:

Fig. 1 is a vertical, longitudinal section thru the regulator, showing the demand valve in its closed position, and the diaphragm at its extreme outward position, and taken on line 1—1 Fig. 3.

Fig. 2 is a similar, vertical, longitudinal section thru the regulator, but showing the demand valve in its open position, and the diaphragm at its extreme inward position.

Fig. 3 is a front elevation of the regulator with a portion of the cover broken away so as to disclose the toggle mechanism.

Similar characters of reference indicate like parts in the several figures of the drawings.

The casing 10 is provided with an inlet duct 11 which is adapted to be tubularly connected, by means of its female threads 12, or otherwise, with a suitable source of oxygen, air or other fluid, or combination of fluids, supplied at substantially constant pressure by means that are well known in the art. The fluid which passes thru, and is controlled by, the mechanism in the regulator, leaves said regulator thru the outlet duct 13 which is adapted to be suitably connected to the mask of the person who is to receive the fluid supplied by the regulator.

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Coaxially with respect to the inlet duct 11, the casing 10 is bored outwardly from its inner face to form an annular recess 14 which is annularly enlarged at its inner end at 15 to receive the annular flange 16 of the demand valve seat 17. (See Patent 2,445,359, Meidenbauer, for details.) Against this valve seat 17 is adapted to rest the demand valve 18 which is of the tiltable type, and is resiliently urged toward its closed position by a conical compression spring 20, the outer, small end of the latter being suitably secured to the stem 21 of the demand valve.

Secured to the front or outer face of the case 10, by means of a cord or string 22, or otherwise, is a flexible diaphragm 23 which is constructed of a synthetic rubber or other suitable material. To the inner or rear face of this diaphragm is cemented a conical, pressure-distributing, metal plate 24, while the outer or front face of said diaphragm is provided with a similar but smaller, conical pressure-distributing, metal plate 25. A flanged pivot post 26 passes coaxially thru both of said conical plates and also thru the center of the diaphragm, and is riveted over at 28 so as to firmly secure all four of these parts together.

To protect the diaphragm 23 and its associated parts against accidental injury, they are covered by a cup-shaped cover 30, which is secured by machine screws 31, or otherwise, to the front or outer end of the casing 10, and is provided with a plurality of holes 32 to allow the outer face of the diaphragm 23 to be exposed to ambient air.

Pivoted at its upper end at 33 to the pivot post 26 is a toggle lever 34 whose lower end is pivoted at 35 to the upstanding end of an L-shaped, bifurcated bracket 36, the lower, inwardly extending, horizontal leg 37 of which is secured by flat-head, machine screws 38 to the lower, outer periphery of the cover 30. A suitable opening 40' is cut thru the cover 30 to clear this bracket 36 and also to clear a pair of tension springs 40 and 40a whose lower ends are pivoted at 41 and 41a to said bracket 36. The upper ends of these springs are pivoted at 42 and 42a to the upper portion of the toggle lever 34.

In the position of Fig. 1, the extreme upper end of this toggle lever 34 rests against the inner end of an adjusting screw 43 which is threaded thru a sleeve 44 that is brazed to the cover 30. This adjusting screw 43 is locked in its adjusted position by an internally-threaded lock cap 45, which not only serves in the capacity of a locknut, but also covers over the end of said adjusting screw so as to minimize tampering therewith, and also helps to exclude dust and enhance the appearance of the apparatus as a whole.

In this position of Fig. 1, the toggle lever 34 is in its extreme, outward, past dead center position. In other words, the pivot 35 at the lower end of said toggle lever 34 is positioned rearwardly of a plane intersecting the axes of the pivots 33 and 41, 41a. Inasmuch as the springs 40, 40a are tension springs, the upper end of said toggle lever 34 is resiliently urged outwardly against the inner end of the adjusting screw 43, and hence all parts connected with the pivot post 26, such as the inner conical plate 24, are resiliently but definitely held away from the tip of the stem 21 of the demand valve 18. This is in sharp contrast to the ordinary demand regulator which has no definite means of holding the diaphragm and its associated parts away from the demand valve. This fact is of importance when the fact is realized that, in some cases, one or more sets of oxygen-breathing equipment may lie for many years ready to be used but without actually being used. In such cases the diaphragm is apt to lose some of its resilience and to sag against the demand valve, in an ordinary regulator.

To open the demand valve 18 requires a sub-ambient

pressure in the casing 10, but the pressure required for this is not very great because said demand valve is not actuated until the inertia of the diaphragm 23, toggle lever 34, and their associated parts have been overcome, and, furthermore, until all of said parts have gained a certain amount of momentum. In addition to this is the fact that, when the inner conical plate 24 has touched the tip of the demand valve stem 21, the toggle lever 34 has almost, if not entirely, reached its dead center position, and hence the tensile force of the tension springs 40, 40a does not impede the opening of the demand valve 18. In practice, an adjustment at or near dead center has proven to be entirely satisfactory, although, if momentum is not taken into account, an adjustment just outside of dead center would be theoretically better.

As the diaphragm 23 moves inwardly still further, the tensile force of said tension springs does, to be sure, decrease in amount, but this is more than made up for by the fact that the effective leverage which said springs exert upon the fulcrum lever 34 is very decidedly increased as the diaphragm moves inwardly. As a result, the resilient force exerted upon the diaphragm 23 by the tension springs 40, 40a increases as said diaphragm moves inwardly. Hence, when the patient inhales quickly and deeply to obtain a large volume of inhaled oxygen (or air), the tension springs act more powerfully to help in quickly opening the demand valve to its full extent than they do when the patient takes a small, slow inhalation. In other words, the present invention acts as a relatively powerful, positive-pressure regulator for quick, deep inhalations, and a relatively weak, positive-pressure regulator for slow, small inhalations. This provides as much positive pressure under varying inhalation conditions, as can be obtained without having the patient feel that he is being "blown up." The latter is known to be psychologically very harmful to the patient and even to persons who are in good healthy shape.

On exhalation, the maximum resilient resistance to diaphragm movement occurs at the start of the exhalation cycle. This is automatically taken care of by two factors operating simultaneously, (1) that the greatest surge of oxygen into the casing 10 occurs when the demand valve 18 is as open, at the start of the exhalation cycle, as much as it will be during any particular exhalation cycle, and (2) the muscles which tend to compress the patient's lungs exert their greatest force at the start of the exhalation cycle.

If the patient should have a relapse and fail to breathe, the demand valve 18 will automatically stay open until a sufficient pressure has been built up in the casing 10 to force oxygen into his lungs. If, then, he regains consciousness, and commences to breathe more or less normally, the regulator will instantly abandon this automatic feature and will fall into step with his natural breathing cycle. This is because, while this regulator functions partially as a positive-pressure regulator, it also functions as a demand regulator.

On exhalation, the momentum of the various mechanical parts plus the momentum of the incoming oxygen causes the toggle lever 34 to flip past its dead center position to the extreme outward position of Fig. 1. (Movement of these parts up to dead center is, of course, caused by fluid pressure emanating from the demand valve.) In the position of Fig. 1 the diaphragm 23 and its associated parts are definitely, though resiliently, held out of contact with the demand valve 18. Hence, if the mask is then removed, there will be no danger of oxygen leaking through the demand valve even if the regulator lies unused for years.

It is to be understood, of course, that the conical, demand valve spring 20 opposes the opening of the demand valve 18 to an increased extent as it opens to an increased extent. This arithmetic increase of resilient resistance is, however, more than offset by the fact that the effective leverage of the tension springs increases as the demand valve moves more and more toward its fully open position.

If, for any reason, the demand valve 18 should become stuck, or the supply of oxygen cut off, the patient will be prevented from strangulation by the opening of a suitable, emergency, air-inlet valve 46.

I claim:

1. A demand valve regulator comprising: a casing adapted to be tubularly connected with a breathing mask; a flexible diaphragm in said casing; a demand valve supplied with fluid under pressure and venting into said casing, and actuated by said diaphragm; a toggle lever pivoted on said casing and movably connected with said diaphragm; and a toggle spring resiliently and directly connecting said toggle lever and said casing and arranged to urge said toggle lever in the one or other direction away from its dead center position.

2. A demand valve regulator comprising: a casing adapted to be tubularly connected with a breathing mask; a flexible diaphragm in said casing; a demand valve supplied with fluid under pressure and venting into said casing, and actuated by said diaphragm but disconnected therefrom; a toggle lever pivoted on said casing and movably connected with said diaphragm; and a toggle spring resiliently and directly connecting said toggle lever and said casing and arranged to urge said toggle lever in the one or other direction away from its dead center position.

3. A demand valve regulator comprising: a casing adapted to be tubularly connected with a breathing mask; a flexible diaphragm in said casing; a demand valve supplied with fluid under pressure and venting into said casing, and actuated by said diaphragm; a single toggle lever pivoted on said casing and movably connected with said diaphragm; and a toggle spring resiliently and directly connecting said toggle lever and said casing and arranged to urge said toggle lever in the one or other direction away from its dead center position.

4. A demand valve regulator comprising: a casing adapted to be tubularly connected with a breathing mask; a flexible diaphragm in said casing; a demand valve supplied with fluid under pressure and venting into said casing, and actuated by said diaphragm; a single toggle lever pivoted on said casing and movably connected with said diaphragm; and a pair of toggle springs straddling said toggle lever and resiliently and directly connecting said toggle lever and said casing and arranged to urge said toggle lever in the one or other direction away from its dead center position.

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